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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/684,000
Filing Date: October 10, 2003
Appellant(s): USIKOV, DANIEL A.

Jody C. Bishop (Reg. No. 44,034)

For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed August 08 2007 appealing from the Office action mailed June 08 2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings, which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of invention contained in the brief is correct.

(6) Grounds of Rejection to be reviewed on Appeal

The appellant's statement of the issues in the brief is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix of Claims to the brief is correct.

(8) Evidence Relied Upon

US 5442674	Picard et al.	Aug 15 1995
US 5053958	Tam	Oct 1 1991
Non Patent Litrature	Elena Loli and Fabiana Zama (The conjugate gradient regularization method in computed tomography problems)	1994

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-6 and 13-20 are rejected under 35 U.S.C. 102(b) as anticipated by Picard et al. (US5442674) hereafter Picard.

1. Regarding Claim 1, Picard discloses a method for processing 2D image data for reconstructing 3D image data in **(Fig 1)** therefrom, the method comprising: receiving a plurality of 2D images **(radiographies on Detector 2)** acquired at different angles of view **(Col 9 Lines 53-54)** and iteratively processing **(Element 4 and Col 9 Lines 42-49)** the received 2D images to reconstruct 3D image data therefrom at **(Col 9 Lines 50-61)**.

2. Regarding Claim 2, see **(Figs 4a and 4b)** of the object as disclosed in Picard.

3. Regarding Claim 3, Picard discloses a method of claim 1 wherein said iteratively processing comprises: processing the received 2D images in accordance with a conjugate gradient algorithm at **(Col 9 Line 6)**.

4. Regarding Claims 4, Picard discloses a method of claim 1 wherein the 2D images are not required to be received in a pre-defined order at **(Col 9 Lines 54-61)**. The reference discloses the 3D reconstruction machine can be built in which X-ray tube/Detector assembly can be fixed on one spot and the 2D images can be captured or X-ray tube/Detector assembly can be rotated about a rigid ring and the 2D images being captured. This shows that there is no need for a specific geometry for X-ray source and sensor array and the 2D images are not required to be received in a pre-defined order.

5. Regarding Claim 5, Picard discloses a method of claim 4 wherein said iteratively processing comprises: processing said 2D images as they are received at **(Col 10 Lines 2-4).** The reference discloses the fact that the 2D images are reconstructed at one particular orientation of the rotating system and as they are received.

6. Regarding Claim 6, Picard discloses the method of claim 4 wherein said iteratively processing comprises: processing 2D images in the order in which they are received at **(Col 10 Lines 20-23)**. The 3D reconstruction is done from the 2D images of (view by view) as in the order they are received.

7. Regarding Claim 13, Picard discloses a radiographic imaging system in **(Fig 1)** acquiring 2D images at different angles of view in **(Col 9 Lines 53-54).**

8. Regarding Claim 14, Picard discloses a cone beam tomography in **(Fig 1).** Picard further discloses conical projections of an object in **(Col 1 Lines 23-32)**.

9. Regarding Claim 15, the Claim is a corresponding system Claim as Claim 1. The discussions are addressed with respect to Claim 1.

10. Regarding Claim 16, the Claim is a corresponding system Claim as Claim 3. The discussions are addressed with respect to Claim 3.

11. Regarding Claim 17, the Claim is a corresponding system Claim as Claim 4. The discussions are addressed with respect to Claim 4.

12. Regarding Claim 18, Picard discloses a system in **(Fig 1)** for processing 2D image data for reconstructing 3D image data therefrom, the system comprising: an imaging system operable to capture a plurality of 2D images **(Elements1 and 2)** at different angles of view **(Col 9 Lines 53-54);** and a 3D reconstruction processor **(Element 4)** communicatively coupled to the imaging system, said reconstruction processor operable to receive the plurality of captured 2D images and iteratively process the received 2D images **(Element 4 and Col 9 Lines 42-49)** to reconstruct 3D image data therefrom in accordance with a conjugate gradient algorithm **(Col 9 Line 6)**. Picard further discloses this at **(Col 5 Lines 5-10)**.

13. Regarding Claim 19, the Claim is a corresponding system Claim as Claim 4. The discussions are addressed with respect to Claim 4.

14. Regarding Claim 20, the Claim is a corresponding system Claim as Claim 4. The discussions are addressed with respect to Claim 4. The order of capturing the 2D images does not require a specific geometry of X-ray Sensor/Detector array.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 7-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Picard in further view of article published by (Elena Loli and Fabiana Zama) hereafter Elena.

15. Regarding Claim 7, Picard discloses all the limitations of Claim 1. Picard also discloses the determination of the parameters at **(Col 2 Lines 3-11 and Col 9 Lines 5-61)**. Picard however does not use the recitation of determining the optimal regularization parameter.

Elena discloses Conjugate gradient method on **(Page 2)**. Elena further determines the optimum regularization parameter on (**Page 3 Lines 1-10)**. Both Picard and Elena are analogous art and are from the same field of endeavor. Therefore it would have been obvious for one of ordinary skill in the art at the time the invention was made, to have determined the optimal regularization parameter as taught by Elena in the device and method for geometrical calibration of an X-ray imaging system of Picard. The determination is necessary to obtain a regularized solution before the convergence of the method by smallest number of iterations as explained on (**Page 3 Lines 1-10 and 6 Lines 1-14 by Elena)**.

16. Regarding Claim 8, Elena discloses the determination of the optimal regularization parameter as explained in Claim 7. Elena also discloses the best approximation of the number of iterations to converge as regularized on **(Page 3 Lines 1-4)**. The merits of Conjugate gradient as a regularization method depend on the determination of the optimal stopping iteration index k. Figures 3 and 4 show that after q iterations the solution will diverge.

17. Regarding Claim 9, see the explanation of Claim 7. Elena further discloses using the L –curve method for the computation of optimal regularization parameter on **Page 6**.

18. Regarding Claim 10, Picard discloses all the limitations of Claim 1. Picard also discloses determining the minimum iterations at **(Col 9 Lines 40-49)**. Picard however does not use the recitation of the optimal number of iterations.

Elena discloses determining the optimal stopping iterations on page 3. The optimum numbers of iterations are necessary to decide when the method must be stopped before the divergence as recited on **(Page 3 Lines 1-10)**. Therefore it would have been obvious for one of ordinary skill in the art at the time of the invention, to have used the teachings of Elena in the method as disclosed by Picard for the above stated reasons.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Picard in further view of article published by Elena and Tam (US 5053958) hereafter Tam.

19. Regarding Claim 12, Picard and Elena discloses all the limitations of Claim 10. Picard and Elena however do not disclose the number of iterations being 5.

Tam discloses the number of iterations being 5 to 10 at **(Col 1 Lines 40-41)**. The references disclosed are from analogous art and from the same field of endeavor. The less the number of iterations for the reconstructed image to converge, it takes less computing time for the reconstruction of 3D image **(Col 1 Lines 61-68)**. Therefore it would have been obvious for one of ordinary skill in the art at the time the invention was made, to have the number between 5-10 iterations for the faster 3D reconstruction as taught by Tam.

(10) Response to Argument

Brief Summary of the reference Picard (5442674):

Picard discloses a device and automatic method for the geometrical calibration of an x-ray imaging system. Picard discloses the" automatic geometrical calibration" which is a method of estimating the calibration coefficients **(geometrical parameters of the 2D projections)** view by view iteratively using the conjugate gradient algorithm **(iteratively processing)** to reconstruct 3D image data by the 3D reconstruction machine. **"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).**

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).

(A) The following discussion relates to the rejection of claims1-6 and 13-20 under 35 U.S.C. 102(b) as being unpatentable over Picard.

1. Appellant's argument ---- Regarding claim 1, the Appellant argues **(page 10 of the Appeal Brief)** " Picard does not teach employing an iterative technique for performing such 3D reconstruction".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. The iterative technique processes the received 2D images and the processed data is used for 3D reconstruction. Nowhere in the scope of the Claim 1 of the current invention it is specified that the iterative technique is for performing 3D reconstruction. The iterative technique is for processing the 2D images received from a radiographic imaging device to construct 3D images supported at **(Para 120 page 40)** of the disclosure. Therefore **"iterations are performed on 2D images and not on 3D images for 3D reconstruction"**. Also the abstract of the current invention clearly recites, **"a conjugate gradient algorithm is utilized to iteratively process captured 2D image data (e.g. pixels) for reconstructing 3D image data (e.g. voxels) therefrom (the**

iteratively processed 2D images)". Nowhere it is mentioned that the conjugate gradient algorithm is used for processing iteratively 3D data. The only data processed iteratively is 2D and after processing the data is used for 3D reconstruction. Further **"the dependent Claim 3 reflects that the received 2D images are iteratively processed in accordance with the conjugate gradient algorithm"**. This proves that the iterative processing is done on 2D image and not on 3D image.

The following citing from the reference Picard shows Iterative processing 2D images and reconstructing 3D image therefrom.

"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and

will be used in every 3D reconstruction step" at (Col 10 Lines 40-44). Therefore Picard meets the limitations of the scope of the Claim 1 as explained above.

2. Appellant's argument ---- Regarding claim 1, Appellant argues **(on page 7of the appeal brief)** that Picard fails to teach, "iteratively processing the received 2D images to reconstruct 3D image data therefrom".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Picard at **(Col 9 Lines 42-44 and 50-54)** teaches iteratively processing the 2D images to reconstruct 3D image data therefrom. The beads that are detected (on 2D detector) are iteratively processed and at each iteration a new parameter is computed which clearly teaches iteratively processing 2D images. The 2D radiographies are used by the "3D reconstruction machine" to reconstruct the 3D data. Picard at **(Col 10 Lines 40-43)** teaches that the parameters of each view -points are obtained **(by iteration)** and are used in the 3D reconstruction step. The appellant on page 7 acknowledges that "Picard is directed to calibrating an X-ray imaging device, in which Picard appears to teach iteratively processing 2D images to automatically determine parameters or calibration coefficients of the x-ray imaging device and its X-ray imaging device may be the device that captures 2D radiographic images at various different angles of incidence so that the captured 2D radiographic images may then be used to reconstruct 3D information" meets the scope of the Claim 1. Picard uses the term "Calibration" for estimating the geometrical parameters of the projections **(Col 7 Lines 44-50)**. The term comprising in Claim 1 does not preclude Picard from having more details. Moreover the device and method of "geometrical calibration" is the iterative processing of the 2D projections to reconstruct 3D image. The following paragraphs support the explanation.

"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).

3. Appellant's argument ---- Regarding claim 1, Appellant argues **(page 7, 9 and 10 of the Appeal Brief)** that Picard does not address **any specific**

"reconstruction techniques" that are employed for performing such reconstruction of 3D information from the captured 2D radiographic images.

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Although the 2D images are used to reconstruct 3D image data, the details of the "reconstruction techniques" are not claimed in claim 1. The appellant is also contradicting himself by reciting **(on bottom of the page 11 of the brief)** that the 3D reconstruction technique that may be employed in Picard for processing the 2D images captured by it's 2D X-ray imaging system to reconstruct 3D image data. At one point the appellant mentions that Picard does teach 3D reconstruction technique and at one point doesn't teach **(at page 11 of the appeal brief)**. Picard teaches, **"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).**

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).

Further Claim 1 recites A method for processing 2D image data for reconstructing 3D image data therefrom, the method comprising: receiving plurality of 2D images acquired at different angles **(object as shown in Fig 1 Picard)** and iteratively processing the received 2D images to reconstruct 3D image data therefrom (as explained above). Nowhere in the scope of the claim 1 it would be interpreted as the specific technique of 3D reconstruction is claimed. The claim scope covers the "3D reconstruction only" without the specifics of the type of technique of 3D reconstruction used.

4. Appellant's argument ---- Regarding claim 1, the Appellant argues **(page 8 bottom of the Appeal Brief)** "Picard's iterative technique is directed solely to calibrate the x-ray imaging device for capturing 2D images".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Picard not only calibrates but also iteratively processes the 2D images to reconstruct 3D images. Picard uses the term "calibration" which means processing the coordinates of the phantom and the coordinates of their projections in 2D referential system of the plane P are exploited to estimate the geometrical parameters **(through iterations)** of the projection: the calibration coefficients at **(Col 7 Lines 44-50)**. Picard further discloses, **"The iterative technique of the conjugate gradient is applied to minimize the mean square**

error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).
This clearly shows that the 3D reconstruction is also done and the iterative technique is not just used for calibrating the device.

5. Appellant's argument ---- Regarding claim 1, the Appellant argues **(page 9 and 10 of the Appeal Brief)** " Picard employs the iterative conjugate gradient algorithm for calibrating its image capture device".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Picard discloses, **"The iterative technique of the conjugate**

gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).
This clearly shows that the 3D reconstruction is also done and the iterative technique is not just used for calibrating the image capture device. The term calibration in respect to Picard's disclosure is a processing of 2D images by conjugate gradient algorithm. The data obtained are used for the 3D reconstruction.

6. Appellant's argument ---- Regarding Claim 2-3 and 13-14, the appellant argues (page 11 of the appeal brief) that "dependent claims 2-3 and 13-14 depend either directly or indirectly from claim 1 thus inheriting all of the limitations of the independent claim 1" due to the reasons presented above for claim 1.

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Please refer to the Examiner's response based on claim 1 in sections 1-5 addressed above. Thus the rejection of Claims 2-3 and 13-14 stays the same and are not overturned.

7. Appellant's argument ---- Regarding claim 4, the appellant argues **(page 11 of the appeal brief)** that "Picard fails to teach that the 2D images are not required to be received in a predefined order for processing" and the appellant's main reason is Picard "does not address any specific technique" for the processing of the received 2D images.

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. The "specific techniques" are not claimed in Claim 4 and Claim 1. First of all Picard discloses, **"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).**

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44). This shows that Picard uses Conjugate gradient algorithm as an iterative method for processing 2D images to construct 3D images. Further it is wrong for the appellant to assume that the method used by Picard is traditional. The disclosure of the present application also acknowledges and supports that through the iterative processing by the conjugate gradient algorithm, the 2d radiographic images need not be acquired in a predefined order **(Page 14 Para0051)**. Thus Picard discloses the iterative processing by the conjugate gradient algorithm; the 2d radiographic images need not be acquired in a predefined order. Picard further discloses wherein the 2D images need not be acquired in a pre-defined order at **(Col 9 Lines 50-61)**. The reference discloses the 3D reconstruction machine can be built in which X-ray tube/Detector assembly can be fixed on one spot and the 2D images can be captured or X-ray tube/Detector assembly can be rotated about a rigid ring and the 2D images being captured. This shows that there is no need for a specific geometry for X-ray source and sensor array and the 2D images are not required to be received in a pre-defined order for processing 3D reconstruction.

8. Appellant's argument ---- Regarding claim 5, the appellant argues **(page 12 of the appeal brief)** "Picard does not address any specific techniques for processing received 2D images to reconstruct 3D image data".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Picard discloses at **(Col 10 Lines 40-44)** that the **"geometrical parameters obtained for each view point are stored in the disk of the machine and will be used in the 3D reconstruction step".** This shows that a technique for the processing of 2D images to reconstruct 3D images is carried out. Also the "specific techniques" are neither claimed in Claims 1,4 and 5.

9. Appellant's argument ---- Regarding claim 6, the appellant argues **(page 12 of the appeal brief)** that "Picard does not address any specific techniques for processing received 2D images to reconstruct 3D image data".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Picard discloses at **(Col 10 Lines 40-44)** that the **"geometrical parameters obtained for each view point are stored in the disk of the machine and will be used in the 3D reconstruction step".** This shows that a technique for the processing of 2D images to reconstruct 3D images is carried out. Also the "specific techniques" are neither claimed in Claims 1,4 and 6.

10. Appellant's argument ---- Regarding Claims 15 and 16, Appellant argues **(on page 13 of the appeal brief)** that Picard fails to teach, "means for iteratively processing the received 2D images to reconstruct 3D image data therefrom".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Picard in **(Fig 1)** and at **(Col 9 Lines 42-44 and 50-54)** teaches iteratively processing the 2D images to reconstruct 3D image data therefrom. The beads that are detected (on 2D detector) are iteratively processed and at each iteration a new parameter is computed which clearly teaches iteratively processing 2D images. The 2D radiographies are used by the "3D reconstruction machine" to reconstruct the 3D data. Picard at **(Col 10 Lines 40-43)** teaches that the parameters of each view -points are obtained **(by iteration)** and are used in the 3D reconstruction step. The appellant on page 7 acknowledges that "Picard is directed to calibrating an X-ray imaging device, in which Picard appears to teach iteratively processing 2D images to automatically determine parameters or calibration coefficients of the x-ray imaging device and its X-ray imaging device may be the device that captures 2D radiographic images at various different angles of incidence so that the captured 2D radiographic images may then be used to reconstruct 3D information" meets the scope of the Claim 1. Picard uses the term "Calibration" for estimating the geometrical parameters of the projections **(Col 7 Lines 44-50)**. The term comprising in Claim 1 does not preclude Picard from having more details. Moreover the device and method of "geometrical calibration" is the iterative processing of the 2D projections to reconstruct 3D image. The following paragraphs support the explanation.

"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44). The system in (Fig 1) is the means for the iterative processing.

11. Appellant's argument ---- Regarding claim 17, the appellant argues **(pages 13 and 14 of the appeal brief)** that "Picard fails to teach that the means for iteratively processing does not require that the received 2D images be received in a predefined order" and the appellant's main reason is Picard "does not teach "means for iteratively processing the received 2D images to reconstruct 3D image data therefrom".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. First of all Picard discloses, **"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).**

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).
This shows that Picard uses Conjugate gradient algorithm as an iterative method for processing 2D images to construct 3D images. Further it is wrong for the appellant to assume that the method used by Picard is traditional. The disclosure

of the present application also acknowledges and supports that through the iterative processing by the conjugate gradient algorithm, the 2d radiographic images need not be acquired in a predefined order **(Page 14 Para0051)**. Thus Picard discloses the iterative processing by the conjugate gradient algorithm; the 2d radiographic images need not be acquired in a predefined order. Picard further discloses wherein the 2D images need not be acquired in a pre-defined order at **(Col 9 Lines 50-61)**. The reference discloses the 3D reconstruction machine can be built in which X-ray tube/Detector assembly can be fixed on one spot and the 2D images can be captured or X-ray tube/Detector assembly can be rotated about a rigid ring and the 2D images being captured. This shows that there is no need for a specific geometry for X-ray source and sensor array and the 2D images are not required to be received in a pre-defined order for processing 3D reconstruction. Also the means are disclosed in the explanation above with respect to (Fig 1).

12. Appellant's argument ---- Regarding claim 18, the appellant argues **(page 14 bottom of the appeal brief)** "Picard fails to teach a reconstruction processor that is operable to receive a plurality of captured 2D images and iteratively process the received 2D images to reconstruct 3D image data therefrom in accordance with a conjugate gradient algorithm".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. Picard discloses a system in **(Fig 1)** for processing 2D image data for reconstructing 3D image data therefrom, the system comprising: an imaging system operable to capture a plurality of 2D images **(Elements1 and 2)** at different angles of view **(Col 9 Lines 53-54);** and a 3D reconstruction processor **(Element 4)** communicatively coupled to the imaging system, said reconstruction processor operable to receive the plurality of captured 2D images and iteratively process the received 2D images **(Element 4 and Col 9 Lines 42-49)** to reconstruct 3D image data therefrom in accordance with a conjugate gradient algorithm **(Col 9 Line 6)**. Picard further discloses this **"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).**

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).

13. Appellant's argument ---- Regarding claim 19, the appellant argues **(page 15 bottom of the appeal brief)** that "Picard does not describe it's 3D reconstruction technique in detail and therefore the 3D reconstruction technique for processing 2D images captured would likely have been understood to be such a traditional method that requires adherence to a predefined order".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. First of all Picard discloses, **"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).**

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44).

This shows that Picard uses Conjugate gradient algorithm as an iterative method for processing 2D images to construct 3D images. Further it is wrong for the appellant to assume that the method used by Picard is traditional. The disclosure of the present application also acknowledges and supports that through the iterative processing by the conjugate gradient algorithm, the 2D radiographic images need not be acquired in a predefined order **(Page 14 Para0051) and as such the method is not traditional, therefore images need not to be acquired in predefined order**. Thus Picard discloses the iterative processing by the conjugate gradient algorithm; the 2D radiographic images need not be acquired in a predefined order. Picard further discloses wherein the 2D images need not be acquired in a pre-defined order at **(Col 9 Lines 50-61)**. The reference discloses the 3D reconstruction machine can be built in which X-ray tube/Detector assembly can be fixed on one spot and the 2D images can be captured or X-ray tube/Detector assembly can be rotated about a rigid ring and the 2D images being captured. This shows that there is no need for a specific geometry for X-ray source and sensor array and the 2D images are not required to be acquired in a pre-defined order for processing 3D reconstruction.

14. Appellant's argument ---- Regarding claim 20, the appellant argues **(page 16 of the appeal brief)** that "Picard does not provide a reconstruction processor that iteratively processes 2D images to re construct 3d image data therefrom in accordance with the conjugate gradient algorithm and Picard further fails to teach such a reconstruction processor that does not require a predefined order of capturing the different angles".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. First of all Picard discloses in (Fig 1) a reconstruction processor 4. Picard further discloses, **"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).**

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44). This shows that Picard uses Conjugate gradient algorithm as an iterative method for processing 2D images to construct 3D images. Further it is wrong for the appellant to assume that the method used by Picard is traditional. The disclosure of the present application also acknowledges and supports that through the iterative processing by the conjugate gradient algorithm, the 2D radiographic images need not be acquired in a predefined order **(Page 14 Para0051)**. Thus Picard discloses the iterative processing by the conjugate gradient algorithm; the 2D radiographic images need not be acquired in a predefined order. Picard further discloses wherein the 2D images need not be acquired in a pre-defined order at **(Col 9 Lines 50-61)**. The reference discloses the 3D reconstruction machine can be built in which X-ray tube/Detector assembly can be fixed on one spot and the 2D images can be captured or X-ray tube/Detector assembly can be rotated about a rigid ring and the 2D images being captured. This shows that there is no need for a specific geometry for X-ray source and sensor array and the 2D images are not required to be acquired in a pre-defined order for processing 3D reconstruction.

(B) The following discussion relates to the rejection of claims 7-10 and 12under 35 U.S.C. 103(a) as being unpatentable over Picard in view of Elena and Tam.

15. Appellant's argument ---- Regarding claims 7-10 and 12, the appellant argues **(page 16 of the appeal brief)** that "Picard does not teach every feature of Claim 1 and neither Picard, Elena and Tam are relied upon as teaching the above noted deficiency of Claim 1". The appellant does not argue the specifics of the dependent claims 7-10 and 12 except the inherited limitations of Claim 1.

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. The following paragraphs support the explanation.

"The iterative technique of the conjugate gradient is applied to minimize the mean square error on all the beads detected (2D image detected at the detector)" at (Col 9 Lines 42-45).

"The term "3D reconstruction machine" is applied to a machine that carries out radiographies of an object at different angles of incidence obtained by rotation about an axis. These radiographies are then used to reconstruct 3D information" at (Col 9 Lines 50-54).

" In the case of a 3D reconstruction machine, the method of automatic calibration is particularly well suited to estimating the calibration coefficients, view by view, in the course of a rotation at (Col 10 Lines 20-23).

"Thus, the geometrical parameters for each viewpoint are obtained. These geometrical parameters are stored in the digital disk of the machine, and will be used in every 3D reconstruction step" at (Col 10 Lines 40-44). Thus all the limitations are met as explained above and in prior Claim 1 Examiners response. The dependent Claims 7-10 therefore stand rejected in view of the above explanation.

16. Appellant's argument ---- Regarding Claims 7-10 and 12, the appellant argues **(page 17 of the appeal brief)** that "Elena proposes application of the conjugate gradient for processing captured 1D image data for reconstructing 2D image data therefrom and it was not apparent to one of ordinary skill in the art whether the conjugate gradient method could be extended for the application in 3D image reconstruction".

Examiner's response ---- The Examiner respectfully disagree with the Appellant's statement. The Non Patent literature published by Elena and Zama and cited herein as a reference by the Examiner clearly shows that the image data is not 1D and is 2D image data. Equation 1 on Page 1 shows a function f(x,y) which is 2D. Also on the bottom of Page 6 the f(u,v) shows it is two dimensional. Also Figs 7-9 shows the images are 2D and are being processed (iteratively). The abstract of the current invention clearly recites, **"a conjugate gradient algorithm is utilized to iteratively process captured 2D image data (e.g. pixels) for reconstructing 3D image data (e.g. voxels) therefrom"**. Nowhere it is mentioned that the conjugate gradient algorithm is used for processing iteratively 3D data. The only data processed iteratively is 2D and after processing the data is used for 3D reconstruction. Also all the Claims recite processing 2D images, therefore there is no question of the algorithm extension to 3D.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Jayesh Patel JP

Examiner

September 12, 2007

Conferees:

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SUPERVISORY PATENT EXAMINER

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